

**GST 2420:**

**Atoms and Stars:**

**A Historical Introduction to Astronomy, Physics,  
and the Process of Scientific Discovery**

Fall 2001

Wednesday: Oakland Center 404, 6-9:40 PM 982 95241  
Thursday: 224 Cohn, 6-9:40 PM 981 90566

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offices  
3:30-5:30 PM, Thursday, Main Campus 2313 A/AB  
or by appointment, phone, or e-mail

Required Texts:

- 1) Atoms and Stars Reader (Interdisciplinary Studies Program, Wayne State University).
- 2) Atoms and Stars Lab Manual (Interdisciplinary Studies Program, Wayne State University).

Copies may be purchased from the instructor.

**Course Description and General Education:**

This course fulfills the university general education requirement in the physical sciences (PS) and includes a required lab component. We will examine selected episodes in the history of physics and astronomy to see how scientists collect information, construct and test hypotheses, evaluate theories, and borrow from other sciences. The focus of the course is on the **process** of scientific investigation. This process takes place in particular historical settings which shape the work of scientists. At the same time, scientific hypotheses are developed, tested, modified, and provisionally accepted or rejected in the light of new information and experimentation. We will explore how scientists decide what makes a good hypothesis about the natural world and how they go about testing it. We will also consider how scientists identify mathematical regularities in nature and use mathematical models to predict new facts about the world. Science's relationship with technology will also be examined. Finally, we will consider the relationship between science and

cultural beliefs and values. This course is intended for non-science majors and does not require any scientific or mathematical background.

### **Course Requirements:**

Students are required to complete the assigned reading before class and to come prepared to discuss it. Occasional quizzes may be given on the reading. Class attendance and participation are required and all assignments should be handed in on time. Laboratory exercises are intended to help you explore the process of scientific discovery rather than to arrive at the "correct" answer. Your laboratory reports and conceptual exercises will be evaluated for effort, attention to detail, exploration of the scientific process, and critical thinking about the nature of discovery. You must take the midterm and final at the assigned date and time (6-7:30 PM) for your section. If you have an unavoidable conflict, you must contact me in advance to arrange another time. You must take both the midterm and the final to complete the course.

### **Class meetings**

I want you to get the most out of class meetings. I aim to ensure that class meetings provide a friendly and effective setting to explore ideas, but this requires your cooperation and consideration.

Please note that all classes begin promptly at 6 PM and will end at 9:40 PM. Please make sure you arrive on time, taking into account rush hour traffic. Late arrivals disrupt the classroom environment for other students. Please make arrangements with your employer to leave early if necessary.

Please do not leave class early. Nothing is more distracting to other students who are working hard to concentrate at the end of a long day than watching students leave who have decided that they've had enough for one day. The material in this course cannot be easily mastered without consistent attendance and participation.

Please do not step outside the class except at breaks: again, this is very disruptive. We will take frequent, short breaks and break up the evening with different kinds of activity (lecture, discussion, lab, videos) to make a long class session manageable and, I hope, interesting.

Also, please turn off all cell phones and beepers and avoid side conversations during lecture or class discussion. If you have a question or comment, ask it! Don't assume everyone else understands what is going on. The concepts discussed in this class require some work to understand but everyone can do so if you work at it and if you let me know when you are confused. In general, consideration for your student colleagues and your teacher will make this a more useful and less stressful class for everyone.

### **Important Note:**

Any plagiarism or cheating will result in an F for the course and referral to the university for further sanctions.

In writing your essays, you should remember to write on the topic *in your own words*. Copying text or closely paraphrasing from another writing or internet source is not allowed. If you use an idea borrowed from another source, you must give a complete citation of the source used. Tests also require you to answer in your own words. Tests are to be taken without use of notes or reading.

Attendance and Participation	10%
Laboratory Exercises	25%
Conceptual Exercises	5%
Essay 1	10%
Essay 2	10%
Mid-Term Examination	20%
Final Examination	20%

### **Schedule:**

Week 1 (Sept. 5,6)	<b>Introduction to the Course</b> <i>Laboratory Exercise I: (Start) The Mystery of the Temperamental Can</i>
Week 2 (Sept. 12, 13)	<b>Seeking Scientific Explanations</b> <i>Readings: <u>Reader</u>, preface, pp. v-vi, pp. 1-12</i> <i>Lab Experiment I, <u>Manual</u>, pp. 1-3</i>
	<hr/> <hr/> <i>Topics: What is Science?; Observation and Forming Hypotheses; Aristotelian Concept: Nature Abhors A Vacuum</i> <i>Laboratory Exercise I: Mystery of the Temperamental Can</i>
Week 3 (Sept. 19, 20)	<b>The Development of the Concept of Atmospheric Pressure</b> <i>Due: Report on Experiment I</i> <i>Readings: <u>Reader</u>, pp. 13-22</i> <i>Lab Experiment II, <u>Manual</u>, pp. 4-5</i>
	<hr/> <hr/> <i>Topics: Development of the Concept of Atmospheric Pressure; Possible Effect of New Anomalous Observations on a Hypothesis; Use of Analogous Observations in Different Contexts</i> <i>Laboratory Exercise II: Torricellian Sea of</i>

### Air Hypothesis

We will talk about upcoming *assignments*:

1) ESSAY I on Scientific Method and the Concept of Atmospheric Pressure (due in two weeks, handout distributed)

2) Conceptual Activity I, Manual, pp. 82-84 (due in one week)

Week 4  
(Sept. 26, 27)

### **Greek Science**

*Due*: Report on Experiment II  
Conceptual Activity 1

*Readings*: Reader, pp. 105-125

Lab Experiment VII, Manual, pp. 30-34

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*Topics*: Early Greek Science and background;  
Aristotle's Conceptions of Motion and Natural Place; Euclid's geometry

*Laboratory Experiment VII*: Measurements of Density and Buoyancy

Week 5  
(Oct. 3,4)

### **Mathematical Regularities in Science**

*Due*: Report on Experiment VII  
Essay I

*Readings*: Reader, pp., 23-29, 74-79

Lab Experiment III, Manual, pp. 6-12

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*Topics*: Mathematical Regularities in Science;

Predictions in Science; Speed of Light;

Boyle's Law; Inclined Plane and Horizontal Projectiles

*Laboratory Exercise III*: Mathematical Regularities in Nature

Talk about upcoming *assignment* (requires beginning now): Conceptual Activity 3, Manual, pp. 86-88 (due in eight weeks)

Week 6  
(Oct. 10, 11)

### **Motions in the Heavens**

*Due*: Report on Experiment III

*Readings*: Reader, pp. 90-104

Lab Experiment VIII, Manual, pp. 35-41

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*Topics*: Apparent Motions of the Stars, Sun, Moon, and Planets

*Laboratory Experiment VIII: Straight Line Horizontal and Vertical "Free Falling" Motion*

Talk about upcoming *assignment* (requires beginning now): Conceptual Activity 3, Manual, pp. 86-88 (due in eight weeks)

Week 7  
(Oct. 17, 18)

**Astronomical Models**

*Due:* Report on Experiment VIII

*Readings:* Reader, pp. 80-89, 157-63  
Lab Experiment IXa, Manual, pp. 42-53

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*Topics:* Geocentric Models - Aristotle and Ptolemy; Heliocentric Models - Copernicus and Kepler; Tycho Brahe's Compromise

*Laboratory Experiment IXa:* Archimedes' Exploits and the Ellipse

Week 8  
(Oct. 24, 25)

**A Case Study: Johannes Kepler**

*Readings:* Reader, pp. 168-225  
Lab Experiment IXb, Manual, pp. 53-59

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*Topics:* Kepler's Life and Method; Tycho's Observations and Kepler's Model of the Solar System

*Laboratory Experiment IXb:* Completion of Archimedes' Exploits and the Ellipse

*Assignment* (begin): Essay II (based on Reader, pp. 254-78; due in four weeks)

**MID-TERM EXAMINATION** (covers weeks 1-7)

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Week 9  
(Oct. 31, Nov. 1)

**Galileo, Astronomy, and the Telescope**

*Due:* Report on Experiment IX

*Readings:* Reader, pp. 126-38  
Lab Experiment X, Manual, pp. 60-63

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*Topics:* Optics, Lens, Telescopes; Observing the Heavens: Qualitative Astronomy

*Laboratory Experiment X:* The Optical Properties of Lenses

Talk about upcoming *assignment*: Conceptual Activity 2, Manual, p. 85 (due in one week)

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Week 10

**Newton, Gravitation, and the Solar System**

(Nov. 7, 8)

*Due:* Report on Experiment X  
Conceptual Activity 2  
*Readings:* Reader, pp. 163-65, 226-38  
Lab Experiment XI, Manual, pp. 64-77

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*Topics:* Newton; Laws of Motion and Gravitation; The Physics of the Solar System  
*Laboratory Exercise XI:* Centripetal Forces and Gravitational Motions

Week 11  
(Nov. 14, 15)

**The Atomic Nature of Matter**  
*Due:* Report on Experiment XI  
*Readings:* Reader, pp. 30-41, 45-60  
Lab Experiment IV, Manual, pp. 13-15

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*Topics:* Atomic Nature of Matter; Atoms and Molecules; Elements, Compounds, and Mixtures; Lavoisier, Dalton, and Avogadro, radioactivity, matter and energy  
*Laboratory Exercise IV:* The Chemical Composition of Water

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Campus Class meets on Tuesday, Nov. 20. (Tuesday counts as a  
\* Thursday that week, according to the university calendar.)  
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Oakland class does not meet until after Thanksgiving recess.  
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Week 12

**The Nature of Heat, Electricity, Light  
Greenhouse Effect**

(Nov. 28, Oakland;  
Nov. 20, campus)

*Due:* Report on Experiment IV  
Essay II  
*Readings:* to be announced  
Lab Experiment V, pp. 16-21

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*Topics:* Heat; Electricity; light spectrum, global warming  
*Laboratory Exercise V:* Thermal Equilibrium

Week 13  
(Dec. 5, Oakland;

**Big Bang Theory and Cosmology**

Nov. 29, campus) *Due*: Essay II  
Report on Experiment V  
*Readings*: Reader, pp. 61-73

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*Topics*: The Big Bang Theory, mathematical  
astrophysics and cosmology, science  
and religion  
*Laboratory*: to be announced

Week 14  
(Dec. 12, Oakland;  
Dec. 6, campus)

**Other Aspects of the Universe**

*Due*: Report on Experiment from Wk. 13  
Conceptual Activity 3  
*Readings*: Reader, pp. 143-56, 166-67, 239-  
43, 251-53  
Lab Experiment XII, Manual, pp. 78-81

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*Topics*: Astronomical Distances and Sizes;  
Comets, Black Holes;  
Probabilities of Extraterrestrial  
Life;  
Overview of Atoms and Stars  
*Laboratory Exercise XII*: The Greenhouse  
Effect: Can Carbon Dioxide Trap Heat?

Week 15  
(Dec. 19, Oakland;  
Dec. 13, campus)

**Final Examination**

(Based on Weeks 8-14)